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MINI REVIEW

Artemisinin's molecular symphony: illuminating pathways for cancer therapy

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Abstract

Artemisinin (ART), a sesquiterpene lactone derived from the sweet wormwood plant (*Artemisia annua*), exhibits potent anti-malarial and anti-microbial properties, with emerging evidence suggesting its anticancer potential. This review delves into the molecular intricacies underlying ART's anticancer effects, elucidating its modulation of cell signaling pathways, induction of apoptosis and autophagy, and inhibition of angiogenesis crucial for cancer progression. Additionally, the review highlights ART's impact on oxidative stress and DNA damage within cancer cells, along with its potential synergistic effects with conventional cancer drugs to mitigate side effects. Despite notable strides, further elucidation of ART's mechanisms and clinical validation across diverse cancer types are necessary. Conclusively, this review provides a brief overview of the molecular foundation that makes ART a promising candidate for future cancer therapeutic strategies and emphasises the need for further research to fully comprehend the molecular complexity of ART-mediated cancer therapies.

Keywords Artemisinin · Cancer · Anti-cancer drugs · Molecular mechanism · Phytocompounds

Background

The study of phytochemistry (plant chemistry), encompasses a broad field of research. Modern advanced techniques are currently employed to explore natural resources and develop applications in the fields of agriculture, medicine, and industry. From that perspective, we hereby review the plant species *Artemisia annua* (sweet wormwood) and its bioactive compound derivatives. The plant was scientifically named by Carl Linnaeus, contains a complex array of phytochemicals, with Artemisinin (ART) being the most well-known and pharmacologically significant compound. ART, with its distinctive peroxide bridge structure, exhibits potent antimalarial properties [1], while other compounds found in *A. annua*, such as sesquiterpenes, flavonoids, and phenolic compounds, also contribute to its therapeutic potential and may synergize with ART. Current research on *A. annua's* chemistry aims to discover new bioactive compounds and understand their pharmacological activities for diverse health applications.

Globally, cancer is one of the major health concerns and the second leading cause of death annually. Current treatment strategies use phytochemicals as anticancer drugs and have potential activity against various types of cancer. According to GLOBOCAN report released in 2024, statistical data recorded 19.9 million new cancer cases and 9.7 million deaths in 2022 [2].

Plants produce diverse metabolites that include a broad spectrum of biochemical compounds that are used to treat many vulnerable diseases [3]. *A. annua* is recognized for its antimalarial, antibacterial, antifungal, anti-inflammatory, antioxidant, and hepatoprotective properties, as well as its ability to alleviate asthma. Recent studies have also explored its potential against cancer [4–7]. This plant is commonly found in several tropical countries such as India, Brazil and Congo. In addition, countries like Kenya, Vietnam, Tanzania, and China consider *A. annua* an industrial crop species [8]. ART mostly accumulates on glandular hairs situated at leaves and flowers in plants [9]. Though ART is emerging as a potential therapeutic drug but due to its poor solubility in oil and water it could be developed as a semi-synthetic drug for pharmaceutical usage. Artesunate (ATS), dihydroartemisinin (DHA), artemether (AM) and artemisone (ATM)

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